MEASURING REACTION TIME AND FORCE EXERTED BY FOOTBALL PLAYERS

BY

Richard J. Rosenfield
B. S. Education, University of Kansas
1947

Thesis
1951
Rosenfield
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Submitted to the Department of Education and to the Faculty of the Graduate School of the University of Kansas in Partial fulfillment of the requirements for the degree of Masters of Science in Education.

Redacted Signature

Instructor in charge

Redacted Signature

For the Department

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ACKNOWLEDGMENT

This study was done under the direction of Dr. Edwin R. Elbel, Professor of Physical Education, University of Kansas. Sincere appreciation is expressed for his kind and thoughtful advice.

The assistance rendered by members of the freshman football squad and the coaching staff is hereby acknowledged. Without their assistance this study could not have been completed.

INTRODUCTION

In the field of reaction time there have been many attempts to differenciate between the responses of athletes and non-athletes and to classify individuals by various measures of response to stimuli. Many studies have been done on the variables which might be considered as acting upon one's reaction time. Some of these studies attempted to: (1) determine the effect of strenuous exercise upon reaction time; (2) the effect of a heavy meal upon reaction time; (3) comparison of reaction time taken at different times throughout the day; (4) the effect of fatigue upon reaction time.

Over a period of years apparently only a few devices have been constructed for measuring response of football players to stimuli.

In this study a piece of apparatus was so constructed to simultaneously measure both speed of response and the force exerted in the charge of football players.

The question of body size in relation to the response of the individual involving body movement has always proven of interest in football.

It has been assumed that a heavy man can exert the greater force but that the lighter individual has a better reaction time as measured in terms of body movement.

There would perhaps be considerable difference of opinion as to whether speed of movement or force exerted is of greater value from the playing standpoint. It must be assumed that each is of importance.

STATEMENT OF PROBLEM

The purpose of this study was to determine the speed of response as measured by the movement of the body and to measure the force exerted by football players in charging against an especially constructed "blocking dummy"; and to construct T-scores for speed of response and for the force exerted during the charge. The importance of bodily weight relative to these two factors was also considered as a part of the problem.

REVIEW OF LITERATURE

In 1931 Mills, W. B. (1) studied the reaction time of 87 football players at Stanford University who responded to a verbal stimulus by a charging motion of the whole body. He used an expecially constructed chronoscope to determine the response of football backs and linemen. The linemen were divided into groups corresponding to the various positions. Each subject was requested to place his head against a trigger which was four inches from a piece of piano wire. The administrator gave the following instructions: "ready-signal-hike." As the "hike" was sounded the chronoscope was started; subjects charged against the trigger, this caused a golf ball to drop to a paper on the chronoscope. This served as a mark for scoring the individual since the speed of movement of the paper was known.

The results of the experiment were as follows:

Position	Mean Reaction Time
1. back	.360 second
2. ends	.377 "
3. guards	.383 "
4. tackles	.395 "
5. centers	.444 "

Elbel (2) conducted a study based upon the movement of the hand to determine the amount of variation of reaction time during different hours of the day. Twenty-three male students from 17 to 33 years of age were used as subjects during a total of 325 periods. The testing of individuals subjects ranged from 87 periods over 11 days to 4 periods for a single day. Subject was tested at 8:20, 9:20, 10:20, and 12:20 A.M.; 1:20, 2:20, 3:20, 4:20, and 5:20 P. M. He concluded that:

1. "There were two periods a day that response scores were the highest, once in the morning and once in the afternoon, and that maximum speed was attained in the afternoon period.

2. The slowest periods for hand response were early and late periods both in the morning and afternoon. The slowest period of the day was at 12:20 P.M.

3. There was a tendency toward a slow response early and late to a high point of efficiency in mid-morning and a maximum of efficiency in mid-afternoon.

4. Group speed-accuracy results do not follow uniform trends. Scores of entire groups show relatively high scores in the first period of the day and relatively low scores during the second period.

5. Results of individual speed-accuracy shows tendency toward a high mean early in the morning and fluctuation throughout the remainder of the day."

Marsh (3) found that there was some change of reaction time from morning to afternoon.

Goodenough (4) conducted a study, "Reaction Time in Relationship with Chronological Age." For this work he measured the reaction time of 246 children, ranging in age from 2½ to 11½ years of age, and 56 college students. Of these, 106 children were retested after an interval of 1 year, and 58 after an interval of 2 years. The conclusions formulated by Goodenough were:

1. "The development of the reactive process during childhood is shown not merely by improved speed of reaction but to an even more marked degree in the gaining of voluntary control over the motor act. The improvement in voluntary control is shown in the gradual reduction of useless accessory movements preceding and accompanying the act of pressing the reaction key, and in fewer signs of bodily tension as age advances. A quantitative indication of this aspect of development is given by the changes with age in the variability in the speed of successive reactions by the same individual. The developmental changes in variability are much more marked than the improvement in average speed.

2. The slight sex difference in favor of the males which previous investigators have reported for adults subjects appears to hold good even in early childhood. The boys in our group tend to surpass the girls of the same age, both in respect to average speed of reaction and in low variability from trial to trial. Sex differences, however, are very small in amount and there is much overlapping between the sexes.

3. In agreement with the usual findings for adults, only a slight relationship was found between scores on intelligence tests which do not involve speed, and the speed of simple reaction for representative groups of child subjects. No relationship between speed of reaction and socio-economic status was apparent. The relationship of reaction speed to height and weight was positive but very low.

4. The degree of physical activity is indicated by time-sampling observations in the nursey school and kindergarden show a small positive relationship to speed of reaction in 5 of 6 group studies. Amount and frequency of laughter during free play was found to be positively related to reaction speed inall of the 6 groups studied, but the correlations were not high."

Elbel (5) attempted to determine the effect of various forms of strenuous exercise upon the response-time of men. The elapsed time between the sound of a bell and the movement of the hand and movement of the body was taken as the response time. The response time was measured before and after strenuous exercise.

One hundred twenty-nine male students ranging in age from 17 to 29 years were divided into 9 groups in accordance with the type of exercise performed. Subjects were placed in groups according to activity as follows:

1. Freshman basketball group
2. Boxing group
3. Fencing group

4. Four stool stepping groups

5. Three intramural basketball groups

A finger response test was administrated to some of the subjects. This was followed by a speed-accuracy test; a hand response test; and a body response test. Other subjects were given a fencing time-accuracy test.

He found no significant change between the finger response taken before and after exercise. The athletic competition groups improved their mean hand and body response times after exercise. For the stool stepping group there was no significant change in the mean after exercise in hand and body responses as compared to the before exercise response. Following exercise the fencing group showed a significant mean improvement in the fencing time-accuracy and in the speed-accuracy test. Elbel concluded that strenuous exercise as given did notlengthen response time and suggested that competition might cause an emotional component causing lengthening of the response time after exercise rather than the exercise itself being the cause of the lessened efficiency.

Forbes (6) made a study of some of the variables affecting visual and auditory reaction times. The finger reaction time for 178 male students varying in age from 17 to 53 years were recorded under different conditions. He concluded that:

1. "The reaction time of sound is more variable than to light."

2. "The reaction time if sounds tends to increase with age, and with proximity to a meal, but is unaffected by practice of fatigue."

3. "A loaded stomach influences to some extent the reaction time to sound, the relationship being inverse, but has no effect on reaction time to light."

4. "Achievement of an established normal reaction time as a result of practice was not found to be possible."

5. "The correlation between the degree of reaction time between light and sound is low and of no practical importance."

Pfitsch, (7) in his study of 100 athletes and 100 non-athletes, attempted to determine whether any significant difference existed between the reaction time and coordination for those groups. Four tests were administrated to each individual. These tests consisted of a body-response test, a hand-response test, a form board test, and a speed-accuracy test. On the basis of the data collected he formulated the following conclusions:

1. "Hand response. Using the hand as the responding member the scores showed the athlete group to be slightly faster than the non-athlete group.

2. Body response. The data relative to this test showed the athlete group to be significantly faster than the non-athlete group. Considering all the test, the greatest difference between the two groups was shown in the results of this test.

3. Form board test. Although there was no significant difference between the means of the two groups in this test there is an advantage in favor of the athletes.

4. Speed-accuracy test. The comparison of the means of the two groups in the results of this test show the means of the athletes to be decidedly better than the non-athletes. While the difference is not statistically significant, it is greater in this test than in any except the body response test.

5. All of the differences favor the athlete group. This is evidence which may be considered sufficient to conclude that the results will always favor the same group."

Pfitsch also compared the mean results of basketball players with those of football players. His findings for this comparison were as follows:

1. "Comparing the groups in the hand response test shows a slight mean difference in favor of the basketball group. Although the difference between the means is not great enough to be significant, the mean difference between the two groups is greater in this test than of the other 3 tests.

2. Comparing the two groups in the body response test also shows a slight mean difference in favor of the basketball group. The difference between the means was not as great as it was in the hand response test.

3. The data also shows that the mean for the basketball group was better than that for the football group in the speed-accuracy test.

4. The data in the formboard test showed a slight mean difference in favor of the football group."

Westerland and Tuttle (8) conducted a study of the reaction time of track men based upon the involuntary response of a "leg muscle." On the basis of their data it was concluded that:

1. "The time of champions was shorter than that of any other group of track men regardless of the distance run.

2. Short distance men respond faster than long distance men.

3. There is a high degree of relationship between speed in running 75 yards, and the reaction time. The relationship was found to be .863."

Tuttle and Lauterback (9) collaberated in a similar study of track athletes based upon the patellar reflex. In this study it was found that a direct relationship existed between reflex times of sprinters and the distance of the race for which they are especially trained to run. The men who run

the shorter distances have shorter reflex times and vice versa. It was also found that a high degree of relationship existed between the reflex time and speed in sprinting.

In a study by Burpee and Stroll, (10) 46 men of a physical education club participated as subjects. The ability of the individual to participate in the physical activities was compared with his reaction time in a test of "small and large muscle action." The subjects were classified into the following groups according to their ability in the physical education activities:

1. Men who participated with marked success.
2. Men who participated with average success.
3. Men who were irregular participants.
4. Men who didn't participate.

Their results showed that the men who participated with marked success, consistently had the faster reaction time. They concluded that, "fast, small muscle reaction is an important factor in attaining marked success in those physical activities, and that fast large muscle reaction is often more important in attaining marked success in physical education activities."

Burley (11) studied the reaction times of 77 male students at the University of Iowa. The subjects were divided into 7 groups as follows:

1. Non-letter winners
2. High school letter winners
3. Football linemen

4. Football linemen

5. Basketball men

6. Baseball men

7. Swimmers

A response test using both a simple visual stimulus and a complex stimulus was administered to each subject. Upon examination of the data it was concluded that:

1. "All individuals reacted more slowly to complex stimuli than their reactions to a simple stimuli.

2. The reactions of all individuals to the complex stimuli were more variable than their reactions to simple stimuli.

3. For the group as a whole the rate of increase of the complex mean standard deviation over the simple mean standard deviation was $3\frac{1}{2}$ times the rate of increase of the complex mean over the simple mean.

4. A significant difference in speed and variability of reaction time existed among football linemen, football backs, basketball men, baseball men, swimmers, high school letter winners, and non-letter winners.

5. Significant difference in mean reaction time of different athlete and non-athlete groups were not always accompanied by equally significant differences in variability.

6. In speed or variability of reaction time the football backs were excelled but once, football linemen twice, high school letter men 8 times, swimmers 11 times, non-letter men 15 times, out of the possible 24 instances in which they could have been excelled.

Keller,(12) in his study of 359 athletes and 227 non-athletes, found that there is a positive relationship existing between the ability to move the body quickly and success in athletic activities. He found that body quickness is not the same in all sports. A person with slow body reaction has a better chance of success in individual sports than in

those sports which he is required to act rapidly to changing conditions and to movements of several team mates and opponents.

Atwell (13) conducted a study to determine if a significant difference existed between the reaction time of male high school students in different age groups, as determined by tests of simple neuro-muscular response. (movement of the hand and movement of the body) A coefficient of correlation of .325 between the hand response test and the body response test indicates that the hand response time of an individual cannot be considered an index of gross body response time.

As Atwell states: "The correlation of .325 between the two tests might possibly be due to the distribution of weight. In several cases it was observed that the subject had a fast hand response time, but seemingly due to an excessive amount of weight was unable to move the body with any amount of speed."

PROCEDURE

For this study 55 members of the University of Kansas Freshman Football Squad were used as subjects. No distinction was made between the relative positions for which the subjects were candidates.

Each subject was tested individually by the same tester, who was the sole operator of the appratus. Each subject was tested under the following conditions:

(1) While wearing complete football uniform.

(2) No strenuous exercise was done before testing.

(3) Each subject was given the benefit of uniform instructions.

(4) Testing was done at relatively the same time each day.

Each subject was tested prior to going to the football practice field. To eliminate any psychological or competive problem the results of the testing were not given to the subjects.

Apparatus

The apparatus consisted of a horizontal "I" beam mounted upon grooved rollers to which a padded dummy was attached by means of a vertical hinged arm (figures 1, 2, and 3). One end of a calibrated spring was attached to the "I" beam while the other was secured to the base of the apparatus. Force exerted upon the dummy caused the movement of the "I" beam and consequently the elongation of the spring. The amount of force exerted was measured on an expecially constructed

scale ranging from 10 to 600 poinds in 10 pound increments. The scale was attached to the base of the apparatus. A pointer which moved with the beam and remained in place until re-set manually, indicated the amount of force exerted in pounds. A spring was attached to the "dummy arm" for the purpose of absorbing the initial impact of the charge. Rapid recoil of the spring attached to the "I" beam was prevented by a large mechanical door closer the arm of which was securely fastened to the beam.

The spring providing resistance to the movement of the "I" beam was 24 inches in length and 2 inches in diameter. It was calibrated at the Mechanical Engineering Laboratory at the University of Kansas.

The grooved rollers upon which the horizontal beam was mounted prevented lateral movement. Heavy casters mounted upon brackets exerted pressure upon the top of the horizontal beam, thus preventing the rear end from tipping upward when force was exerted upon the dummy.

The stimulus for the charge was the sound made by the timing device-A Centeral Scientific Company Impulse Counter. The timer and starting signal were instituted by the operator pressing a telegraph key. A sensitive "break" switch placed at the junction of the dummy arm and the sliding beam caused a "break" in contact when the dummy was struck. In other words, timing started with the auditory stimulus and ceased when the subject struck the dummy.

The pointer for reasuring the exerted force; the "break" switch; the timer; and the colibration scale pointer were re-set manually after each trial.

METHOD OF TESTING

The Freshman Coach, before practice each afternoon, selected the subjects to be tested. Prior to testing it was explained that the results of the test would have no bearing on their football opportunities.

Since the measurements were being taken in the late fall, the subjects were instructed to keep moving about so as not to become cold.

Each subject as he came to the apparatus was given information as the nature of the device and that he would be given one practice trial to "feel out" the apparatus and become familiar with the auditory stimulus which was the sound made by the timing device when in operation.

After the subject had taken his practice trial he was required to take three additional trials.

Speed of charge was recorded in 1/120th of a second after which times were transposed to units of 1/100th of a second by means of a conversion table. Force exerted by the charge was recorded in pounds.

The time lapse between each trial was one and one-half minutes. This enabled the tester to re-set the apparatus for the next trial.

The following procedure were followed by each subject.

(1) Assumed charging stance with hand or hands on a line at a distance of one foot from the apparatus.

(2) Dropped to one knee in a resting position until the word "ready" was given.

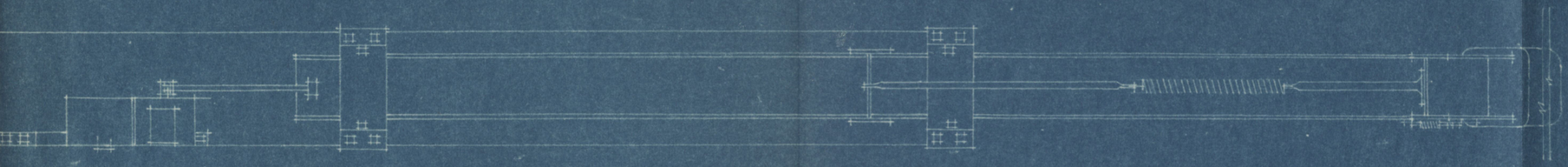
(3) The auditory stimulus was sounded so the subject would be acquainted with it.

(4) When the word "ready" was given, the subject assumed a position of readiness.

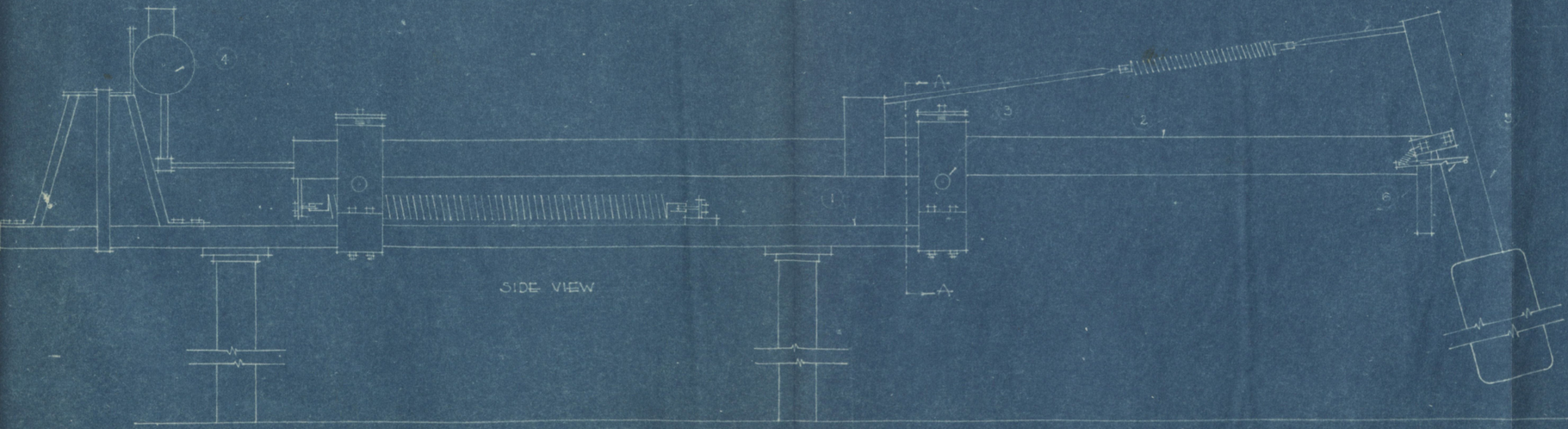
(5) At the sound of the buzzer the subject charged.

FOOTBALL CHARGING MACHINE

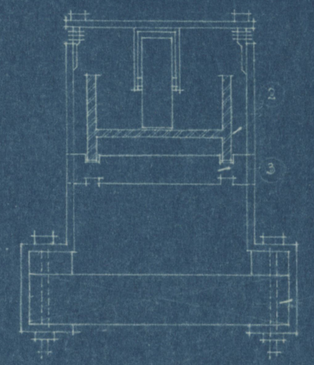
SCALE - 1/8" = 0'-1"



TOP VIEW



SIDE VIEW



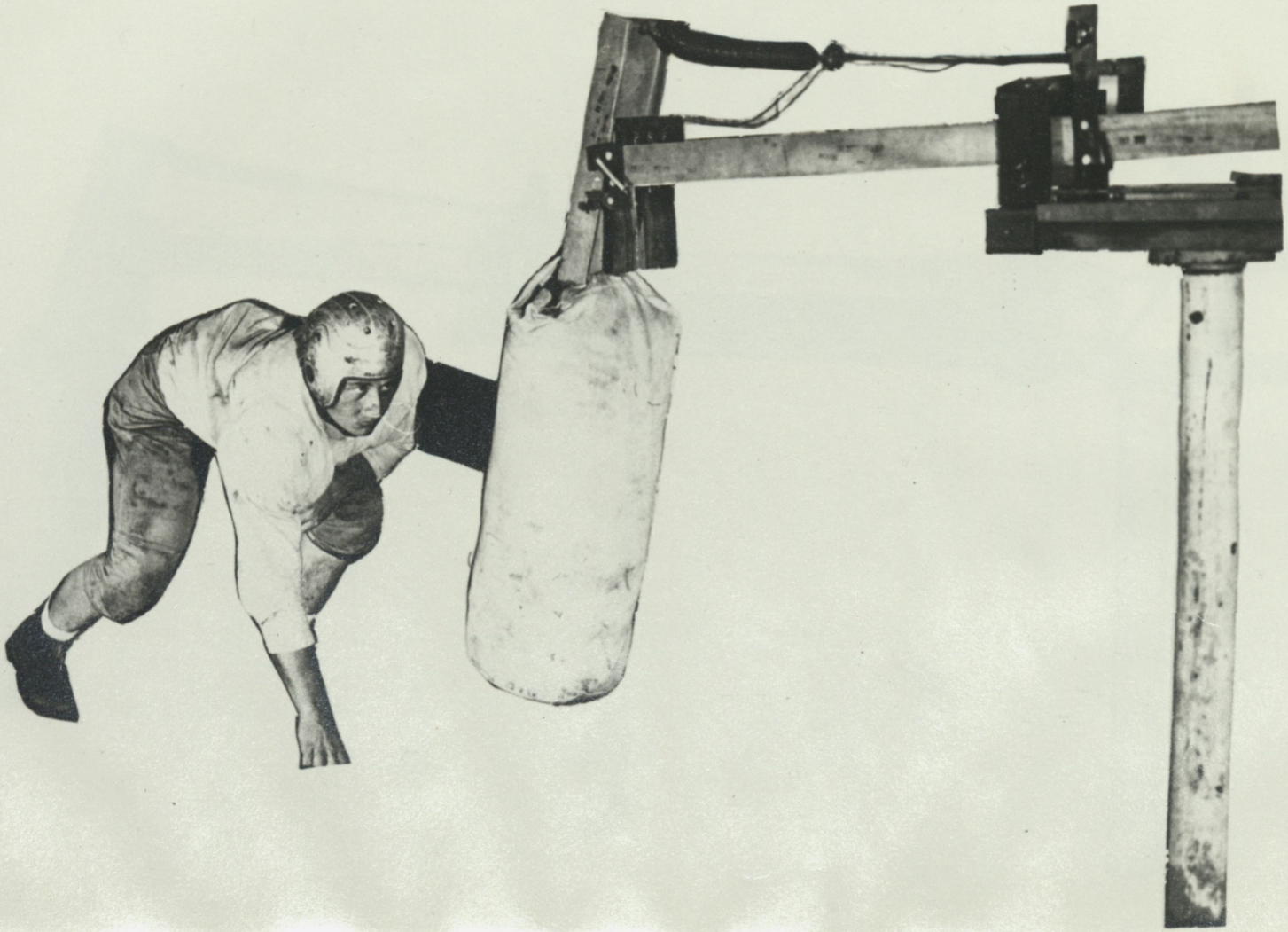
SECTION A-A

SCALE - 1/4" = 0'-1"

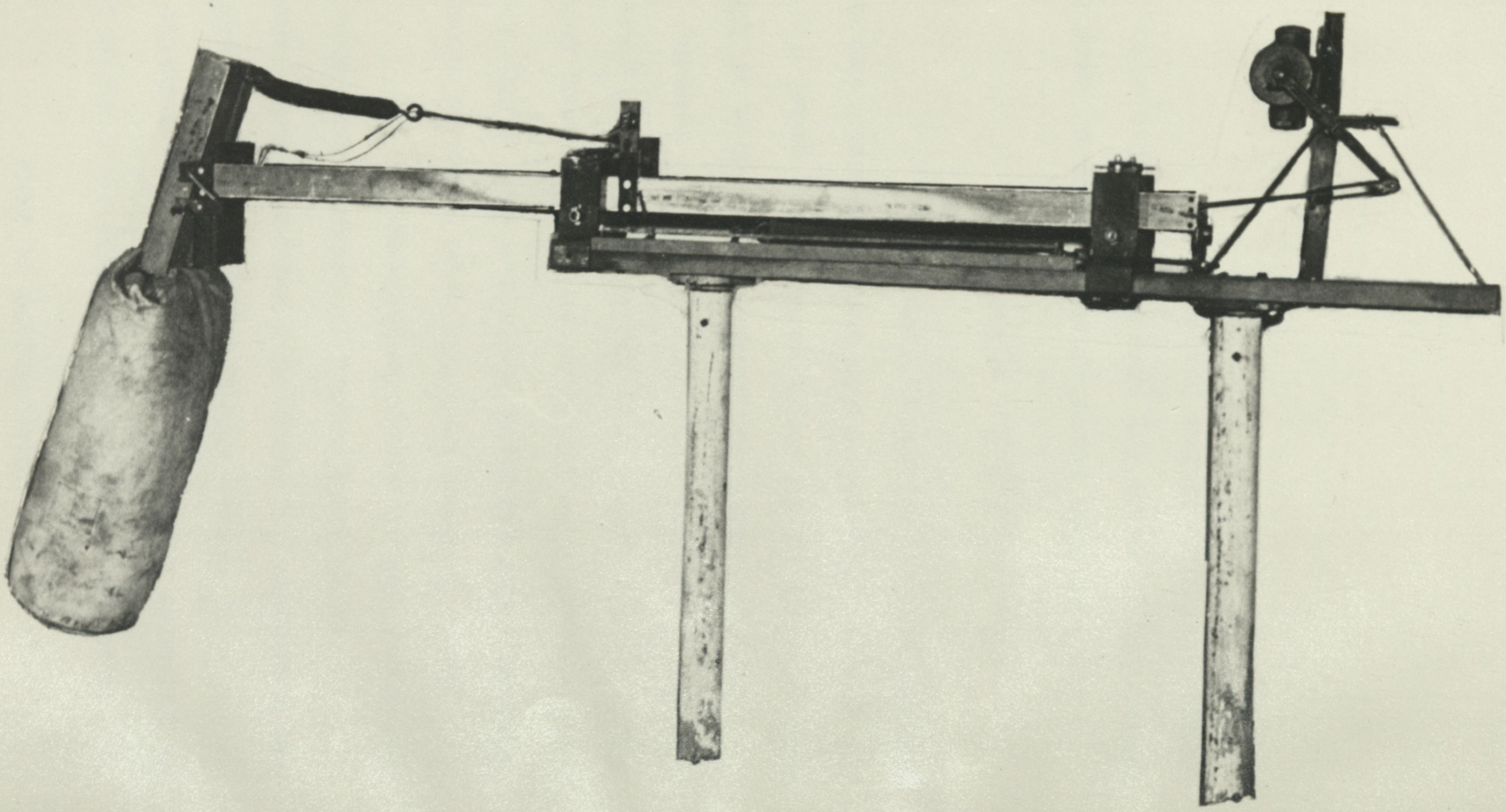
1. BASE PLATE
2. HORIZONTAL BEAM
3. ROLLER
4. DOOR STOP FOR RECOIL
5. VERTICAL BEAM FOR BODY CONTACT
6. LOCK

4/16/45

FOOTBALL CHARGING MACHINE



FOOTBALL CHARGING MACHINE



PRESENTATION OF DATA

The following data are based upon individual performances of subjects on the football charging apparatus with respect to speed of charge and the amount of force exerted. The data are presented in terms of a mean scores of three trials.

Standard statistical procedures were used for determining the means and standard deviations.

Table I shows that the mean speed of charge was .5405 seconds. The standard deviation was .0522, and the range was from .4510 to .7250 seconds. The mean force exerted was 262.6 pounds. The standard deviation was found to be 37.4 and the range was from 203.2 to 361.6 pounds.

T-scales were designed on the basis of 100 increments with a score of 50 for a performance equal to the means for the group. The value for each increment was determined by the use of the following formula:

$$\frac{6 \times S D}{100} = \text{increment}$$

The combined score of an individual were determined by adding the T-score for speed of response with that for the force exerted. (Tables 3 and 4)

TABLE I

NUMBER OF CASES, MEANS, AND STANDARD DEVIATIONS FOR THE FORCE EXERTED AND THE SPEED OF CHARGE.

Activity	No. cases	Mean	S D
Force	55	262.6	37.45
Speed	55	.5436	.0544

TABLE 2

COEFFICIENTS OF CORRELATION BETWEEN FORCE EXERTED AND SPEED OF CHARGE; FORCE EXERTED AND WEIGHT; SPEED OF CHARGE AND WEIGHT.

Activity	Coefficients of correlation
Force vs speed	+ 0.0922
Force vs weight	+ 0.5114*
Weight vs speed	- 0.0758

* Significant on a one per cent level of probability.

TABLE 3

T-SCALE - BASED UPON A STANDARD SCORE FROM 0-100 POINTS WITH MEAN PERFORMANCE OF .5405 SECONDS SCORING 50 POINTS.

50-.5405 = Mean	100-.385
49-.544	99-.388
48-.547	98-.391
47-.550	97-.394
46-.553	96-.397
45-.557	95-.400
44-.560	94-.403
43-.563	93-.406
42-.566	92-.409
41-.569	91-.412
40-.572	90-.415
39-.575	89-.418
38-.578	88-.421
37-.581	87-.424
36-.584	86-.427
35-.588	85-.430
34-.591	84-.433
33-.594	83-.436
32-.597	82-.439
31-.600	81-.442
30-.604	80-.445
29-.607	79-.448
28-.610	78-.451
27-.613	77-.454
26-.616	76-.457
25-.620	75-.461
24-.623	74-.464
23-.626	73-.467
22-.629	72-.470
21-.632	71-.473
20-.636	70-.477
19-.639	69-.480
18-.642	68-.483
17-.645	67-.486
16-.648	66-.489
15-.652	65-.493
14-.655	64-.496
13-.658	63-.499
12-.661	62-.502
11-.664	61-.505
10-.668	60-.509
9-.671	59-.512
8-.674	58-.515
7-.667	57-.518
6-.680	56-.521
5-.684	55-.525
4-.687	54-.528
3-.690	53-.531
2-.693	52-.534
1-.696	51-.537

TABLE 4

T-SCALE - BASED UPON A STANDARD SCORE FROM 0-100 POINTS WITH MEAN PERFORMANCE OF 262.6 LBS. SCORING 50 POINTS.

50-262.6 = Mean	100-373.6
49-260.4	99-371.4
48-258.2	98-369.2
47-256.0	97-367.0
46-253.8	96-363.8
45-251.6	95-361.6
44-249.4	94-359.4
43-247.2	93-357.2
42-245.0	92-355.0
41-242.8	91-352.8
40-240.6	90-350.6
39-238.4	89-348.4
38-236.2	88-346.2
37-234.0	87-344.0
36-231.8	86-341.8
35-229.6	85-339.6
34-227.4	84-337.4
33-225.2	83-335.2
32-223.0	82-333.0
31-220.8	81-330.8
30-218.6	80-328.6
29-216.4	79-326.4
28-214.2	78-324.2
27-212.0	77-322.0
26-209.8	76-319.8
25-207.6	75-317.6
24-205.4	74-315.4
23-203.2	73-313.2
22-201.0	72-311.0
21-198.8	71-308.8
20-196.6	70-306.6
19-194.4	69-304.4
18-192.2	68-302.2
17-190.0	67-300.0
16-187.8	66-297.8
15-185.6	65-295.6
14-183.4	64-293.4
13-181.2	63-291.2
12-179.0	62-289.0
11-176.8	61-286.8
10-174.6	60-284.6
9-172.4	59-282.4
8-170.2	58-280.2
7-168.0	57-278.0
6-165.8	56-275.8
5-163.6	55-273.6
4-161.4	54-271.4
3-159.2	53-269.2
2-157.0	52-267.0
1-154.8	51-264.8

Reliability

The reliability of the test items were determined by correlating the results of the first trial by each individual with the results of the second trial. The coefficient of reliability of speed of response was found to be 0.790 and that for force exerted was 0.851. On the basis of these coefficients of reliability it was concluded that the two test components showed an acceptable degree of reliability.

Validity

The combined scores based upon T-scores for speed of charge and force exerted determined his score for the apparatus. The rating of the players by the two coaches at the University compared with the scores of the players as made on the football charging machine are as follows: Example: Head Coach rated subject number 17 first (see appendix). His score on charging apparatus was first. He rated number 7 second while the score for this subject on the apparatus was seventh.

TABLE 5

Ratings of players as based upon the subjective judgement of head coach as compared to score on apparatus.

Rating Position	Coach (Subject No.)	Apparatus (Subject No)
	Linemen	
1st	17	17
2nd	7	21
3rd	55	55
4th	36	9
5th	3	54
6th	53	36
7th	54	7
	Backs	
1st	49	49
2nd	8	8
3rd	24	24
4th	38	38

TABLE 6

RATINGS OF PLAYERS BASED UPON THE SUBJECT JUDGEMENT OF FRESHMAN COACH AS COMPARED TO SCORE ON APPARATUS

Rating Position	Freshman coach (Subjects No.)	Apparatus (Subjects No)
	Linemen	
1st	17	17
2nd	7	21
3rd	55	55
4th	36	9
5th	54	54
6th	9	36
7th	21	7
	Backs	
1st	49	49
2nd	8	8
3rd	24	24
4th	38	38

From the preceding tables it is apparent that the results obtained from use of the apparatus, although measuring only speed of response and force exerted, compares very favorably with subjective ratings by the coaches. The head coach rated 5 out of the 7 linemen showing the highest combined scores for T-scores devised on the apparatus. The first 5 backfield men picked by the head coach were also the first 4 as a result of the scores made on the apparatus. The freshman coach rated the linemen within the first 7 places determined by the apparatus. Three places coincided. As to backs the four selections of the freshman coach coincided with the scores determined by the apparatus.

DISCUSSION

The coefficient of correlation between the force exerted and the speed of charge (ƒ .0922) shows that there is no relationship existing between the speed of charge of the individual and the force exerted. The initial speed of an individual plays a very insignificant part upon the amount of force exerted by a football player charging from the line of scrimmage. As Mills (1) states, "speed, in football, is important but first of all it is wise to discover who has the speed and in what degree".

A coefficient of correlation between the amount of force exerted and the weight of the individual (.5144) indicats that there is some relationship existing between the individuals weight and the force exerted. While significant this coefficient of correlation cannot be considered large enough to use for predictive purposes. Rather, it indicates that at least some of the smaller individuals exerted force out of proportion to that exerted to heavier players.

An interesting observation by Mills (1) is that he found a coefficient of correlation between the weight of the individual and the reaction time of ƒ .22 to ƒ 09. Compared to a coefficient of correlation in this study a correlation of ƒ.0758 between these two variables. However the two studies indicate that there is no significant relationship between the speed of charge and weight of an individual.

The factor of variation of response time during different periods of the day as shown by Elbel (2) should not alter the

results obtained in this study to any significant extent. The subjects were tested, as mentioned before, at relatively the same time and under the same conditions each day. The age group of the individuals should bring no significant affect upon the data because all were freshmen at the University of Kansas.

SUMMARY AND CONCLUSIONS

This study was done to measure the speed of charge in response to an auditory stimulus and the force exerted by the charge of football players. Fifty-five University of Kansas freshman football players were used as subjects. From the data compiled in this study it was concluded that:

1. There was no significant relationship existing between the force exerted by the charge of a football player and the speed of charge of the individual.
2. There was a significant but low coefficient of correlation exerted and the weight of the individual.
3. There was no significant relationship existing between the weight of the individual and the speed of charge of the individual.
4. The coefficient of Reliability for the speed of charge determined by the correlation of the first and second trials was found to be 0.790; for force exerted it was 0.851.

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APPENDIX

CONVERSION TABLE

120th of a Sec.	---TO---	100th of a Sec.	100th of a Sec.	---TO---	100th of a Sec.
1		.0083	51		.425
2		.0167	52		.433
3		.025	53		.442
4		.033	54		.450
5		.041	55		.458
6		.050	56		.466
7		.058	57		.475
8		.066	58		.483
9		.075	59		.492
10		.083	60		.500
11		.091	61		.508
12		.100	62		.517
13		.108	63		.525
14		.117	64		.533
15		.125	65		.542
16		.133	66		.550
17		.142	67		.558
18		.150	68		.567
19		.158	69		.575
20		.167	70		.583
21		.175	71		.592
22		.183	72		.600
23		.192	73		.608
24		.200	74		.617
25		.208	75		.625
26		.217	76		.633
27		.225	77		.642
28		.233	78		.650
29		.242	78		.658
30		.250	80		.666
31		.258	81		.675
32		.267	82		.683
33		.275	83		.692
34		.283	84		.700
35		.292	85		.708
36		.300	86		.716
37		.308	87		.725
38		.317	88		.733
39		.325	89		.742
40		.333	91		.750
41		.342	91		.758
42		.350	92		.766
43		.358	93		.775
44		.367	94		.783
45		.375	95		.792
46		.383	96		.800
47		.392	97		.807
48		.400	98		.816
49		.408	99		.825
50		.417	100		.833

(continued)

120th of a Sec.	---To---	100th of a Sec.
101		.840
102		.850
103		.858
104		.866
105		.875
106		.883
107		.891
108		.900
109		.908
110		.916
111		.925
112		.933
113		.941
114		.950
115		.958
116		.967
117		.975
118		.983
119		.992
120		1.000

Subject	Weight	Position	Time 1st	Force	Time 2nd	Force	Time 3rd	Force	Average Time 1/120 Sec.	Average Force	Average Time 1/100 Sec	Score (Time)	Score (Force)	Total Score	Rating	
1	178	Line	79	279.1	82	227.1	83	219	81	241.7	.675	8	40	48	39	
2	163	"	78	192.	77	204.1	78	204.1	77	200.1	.642	18	22	40	40	
3	205	Back	73	254.1	72	290	74	271.1	73	271.3	.608	29	54	83	26	
4	174	Line	77	269	74	269	62	269	71	269	.592	34	53	87	25	
5	185	"	82	227.1	82	237.2	97	254.1	87	239.5	.725	8	40	32	41	
6	168	"	77	252.1	79	267	71	285.2	76	268.1	.633	21	52	73	34	
7	190	"	52	227.1	60	244	55	254.1	56	241.7	.466	73	40	113	10	
8	195	"	65	275	62	279	60	271.1	62	275	.517	57	56	113	10	
9	195	Back	64	294	53	312	67	267	61	291	.508	60	63	123	6	
10	150	Line	73	221	74	258.2	72	256.2	73	244.8	.608	29	42	71	36	
11	178	Back	65	290	72	279.1	73	315	70	292.3	.583	36	63	99	19	
12	150	Line	73	240	64	212.2	64	233.2	68	228.5	.567	42	35	77	30	
13	165	"	66	256.1	62	262.2	80	264	69	259.1	.575	39	63	102	17	
14	185	Back	57	294	55	279.4	53	290	55	287.3	.458	45	61	106	14	
15	183	"	73	190	65	212.2	67	225.1	68	209.1	.567	42	26	68	38	
16	134	Line	60	181.2	70	215	67	223.1	66	206.4	.550	47	24	71	36	
17	220	Back	69	344	60	358.2	56	385.2	62	362.4	.517	57	95	152	1	
18	179	Line	60	248.1	64	256.1	80	227.1	68	266.4	.567	42	52	94	22	
19	174	Line	67	277.1	67	265	60	279.1	64	273.4	.533	52	55	107	13	
20	164	Back	60	215	65	202.1	55	206.2	60	207.4	.500	63	25	88	24	
21	185	Line	80	256.2	70	310.2	80	315	59	290.4	.492	65	63	128	3	
22	160	Back	61	256.1	65	254.1	68	271	65	260.4	.542	50	49	99	19	

Subject	Weight	Position	Time 1st	Force	Time 2nd	Force	Time 3rd	Force	Average Time 1/120 Sec.	Average Force	Average Time 1/100 Sec.	Score (Time)	Score (Force)	Totat Score	Rating	
23	200	Line	67	271.1	65	292	69	302.1	64	291.	7.533	52	63	115	9	
24	165	Back	65	265	70	285.2	65	273.1	66	274.	4.550	47	65	112	11	
25	200	Line	69	223	60	248	64	215	64	229	.533	52	35	87	25	
26	185	"	71	192	61	200	64	219	65	204	.542	50	23	73	34	
27	196	"	59	240	74	233	68	294	67	254.9	.558	45	46	91	23	
28	167	"	60	229.1	55	273.1	70	290	62	264	.517	57	51	108	12	
29	140	Back	66	202.1	63	185	60	240	63	202.4	.525	55	23	78	29	
30	175	"	67	260.2	60	265	59	235.2	62	253.4	.517	57	46	103	16	
31	195	Line	77	240	70	206.2	64	287.2	70	244.4	.583	36	42	78	29	
32	207	"	76	240	72	240	71	256.1	73	245.4	.618	29	42	71	36	
33	163	"	66	198.1	64	215	61	204.1	64	205.7	.533	52	24	76	31	
34	163	"	62	242	74	215	70	204.1	69	243.4	.575	39	41	80	28	
35	162	Back	77	240	71	258.2	73	254.1	74	250.7	.617	26	45	71	36	
36	205	Line	75	340	71	373.1	73	346.1	74	353	.642	28	91	119	8	
37	200	"	78	340	70	290	70	273.1	72	301	.600	31	67	98	20	
38	165	Back	55	265	73	244	60	265	55	258	.458	76	48	124	5	
39	180	"	62	250.1	65	250.1	65	240	64	246.4	.533	52	43	95	21	
40	166	Line	65	227.1	68	202.1	64	215	66	214.7	.440	47	28	75	32	
41	170	"	72	198	64	183.2	63	248	66	208.4	.550	47	25	72	35	
42	170	Back	74	254.1	68	231.2	70	273.1	70	252.8	.583	36	46	82	27	
43	207	Line	68	306.2	68	310.2	70	290	69	302.1	.575	39	68	107	13	
44	180	"	74	256.2	62	294	60	250.1	65	266.7	.542	50	52	102	17	

Subject	Weight	Position	Time 1st	Force	Time 2nd	Force	Time 3rd	Force	Average Time 1/120 Sec.	Average Force	Average Time 1/100Sec.	Score (Time)	Score (Force)	Total Score	Rating
45	170	Back	64	210.2	65	273.1	60	265	63	249.4	.525	55	44	99	19
46	140	"	62	279.1	65	229.1	60	281.2	66	263.1	.550	47	51	98	20
47	224	Line	71	219	72	294.0	75	227.1	72	246.7	.600	31	43	74	33
48	213	"	67	323.1	64	348.1	63	381.2	65	350.8	.542	50	90	100	18
49	177	Back	55	298.1	55	275.1	52	265	54	279.4	.450	78	66	144	2
50	165	"	70	294	63	254.1	67	290	66	279.3	.550	47	58	105	15
51	170	"	75	275.1	75	223	72	250.1	74	249.4	.617	26	44	70	37
52	162	"	64	231.1	63	278	61	231.1	62	246.7	.517	57	43	100	18
53	190	Line	72	258.2	68	273	61	275.1	67	268.7	.558	42	53	98	20
54	190	"	70	306.2	67	304.1	66	346	67	318.7	.558	45	76	121	7
55	170	"	59	252.1	55	302.1	56	273	57	275.7	.475	71	56	127	4